25. Apparatus according to Claim 20, characterized by one or several laser diodes.

26. Apparatus according to Claim 20, characterized by a hand-held sensor.

27. Apparatus according to Claim 20, characterized by a device for visualization of the recorded images or phase images as a film.

REMARKS:

The claims in the application are 1-27.

Favorable consideration of the application as amended is respectfully requested.

The claims have been amended to eliminate all multiple dependencies with the specification being amended to eliminate informalities (a marked-up copy is enclosed).

Early favorable action is earnestly solicited.

Respectfully submitted,

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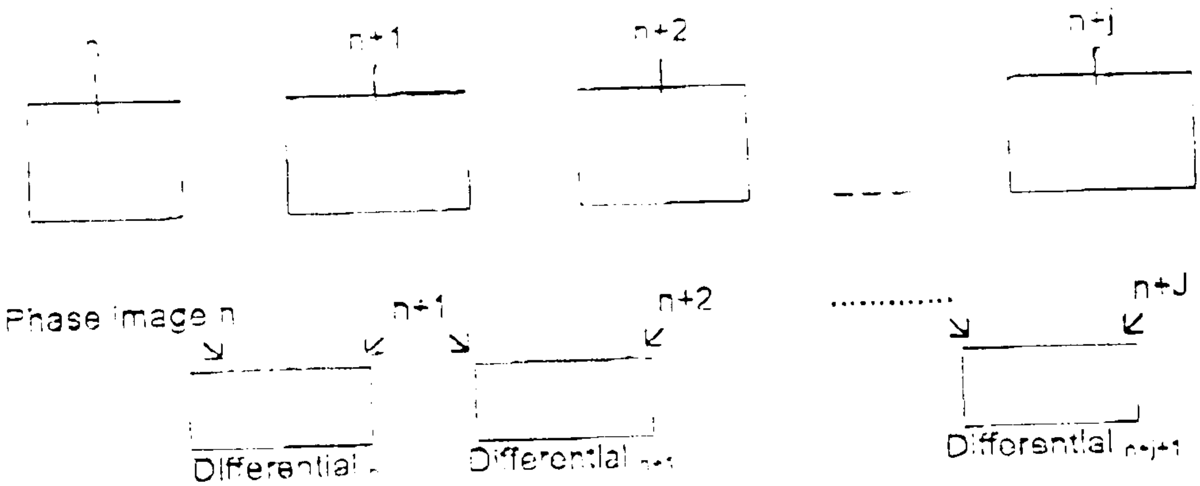
Fig. 2



Differential between phase image n+j and phase image n

$$= \sum_{j=n}^{(n+j-1)} \text{Differential}_j$$

In the process according to the invention, a relatively large number of images are recorded per unit time. In the practical application of the process, it is possible to record the images at the normal video clock frequency of 25 frames per second.

However, it is also possible to apply different image frequencies. In the case of slow deformations, image frequencies of one frame per minute or even lower may be applied. However, it is also possible to record the images at higher frequencies of up to one million frames per second.

In this process, a certain image is used as the starting image. Then the differentials of two sequential images are calculated and successively added together. As a relatively large number of images are recorded per unit time, these images differ by only a comparatively small degree of deformation in each case. The images are recorded during application of the load, i.e. during the advancing deformation process. As a relatively large number of images is recorded per unit time, the interference lines or projection lines are far enough away from each other in order to ensure that they can always be readily evaluated. The deformations are added together, i.e. integrated. In this way, it is also possible to record large deformations.

Preferred embodiments of the invention are described Here in ~~the~~ s~~ubordinate claims~~.

The images of the object can be recorded by means of an interferometry process. Suitable interferometry processes include, for example, holographic interferometry, electronic speckle pattern interferometry (ESPI) or speckle shearing

appertaining to the disrupted image or phase image is extrapolated from the adjacent time intervals. The missing interval is replaced by the preceding differential and/or the following differential.

In order to be able to perform an evaluation even in the case of a discounted image or phase image, the resolution should be selected such that it is still possible to effectively distinguish between the interference lines or projection lines if an image is omitted. The theoretical minimum interval between two adjacent lines is two pixels. In order to ensure reliable evaluation, however, the interval between two adjacent lines should be at least four or five pixels. This will ensure that the lines are still readily distinguishable even if an image or phase image should be omitted.

The recorded images or phase images can be visualised as a film.

It is possible to compare any timeframes of the deformation with one another.

The task on which the invention is based is achieved in the case of an apparatus for recording the deformation of objects by a measuring device for recording a sequence of images of the object during the deformation of said object, and by an evaluation device for forming the differential between two sequential images and for integrating the differential.

Preferred embodiments of the apparatus according to the invention are described BELOW ~~in the further subordinate claims~~.

focal plane generated by the coherent radiation on the body covers at least three sensor elements (pixels). This ensures that a complete phase measurement is possible with a single frame. The phase of the radiation from the object is determined by intensity signals from the sensor elements.

In the prior-art processes for recording the deformation of objects, difficulties can arise if the deformations are relatively large. In this case, the intervals between the various interference lines may be very small with the result that they can only be distinguished with difficulty, or may not be distinguishable at all, so hampering or negating evaluation.

The task of the invention is to introduce a process and an apparatus of the type mentioned at the beginning which facilitates reliable evaluation even in the case of relatively large deformations.

According to the invention, this task is achieved in the case of a process of the generic type mentioned at the beginning, by the FOLLOWING characteristics ~~of Claim 1~~. During the deformation of the object, a sequence or series of images of the object is recorded with a measuring process. The differential (increment) between two sequential images is formed and this is then added to the first image. In the subsequent series of operations performed in the process, the differentials are formed between each two sequential images, and these differentials are added to the preceding image in each case. In this way, the incremental deformations are thus added together, i.e. integrated. The integrated differentials yield the total deformation of the object.

Claims

1. Process for recording the deformation of objects (1),

   in which a sequence of images of the object (1) is recorded with a measuring process during the deformation process,

   the differential is formed between two sequential images (n, n + 1, n + 2)

   and this differential is added to the first image.

2. Process according to Claim 1, characterised in that the images of the object (1) are recorded with an interferometry process, preferably with holographic interferometry or electronic speckle pattern interferometry (ESPI) or with speckle shearing interferometry.

3. Process according to Claim 1, characterised in that the images of the object (1) are recorded with a projection process, preferably with a grid projection process or with a Moiré process.

4. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that phase images are determined from the images.

5. Process according to Claim 4, characterised in that the phase image is determined from one image.

6. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that the object (1) is irradiated with coherent radiation or coherent light, particularly laser light, or with partially coherent radiation or partially coherent light.

7. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that the object is irradiated by a laser diode.

8. Process according to ~~one of~~ Claim~~s~~ 1 ~~to 6~~, characteri~~s~~zed in that the object is irradiated by several laser diodes.

9. Process according to Claim 8, characterised in that the illumination areas of the laser diodes do not overlap.

10. Process according to Claim 8, characterised in that the illumination areas of the laser diodes overlap.

11. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characterised in that the images or phase images of the object are recorded by a hand-held sensor (2).

12. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characterised in that a disrupted image or phase image, or the differential formed therefrom, is precluded from the evaluation stage.

13. Process according to Claim 12, characterised in that the disrupted image or phase image or the differential formed therefrom is ignored.

14. Process according to Claim 12, characterised in that the gap caused by the disrupted image or phase image, or the disrupted differential, is filled by the preceding and/or subsequent differential.

15. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that the recorded images or phase images, or the differentials formed therefrom, is visuali~~s~~zed as a film.

16. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that timeframes or phases of the deformation can be compared with one another.

17. Process according to ~~one of the preceding~~ Claim~~s~~ 1, characteri~~s~~zed in that the whole-body deformation or an undesired deformation is subtracted from the total deformation.

18. Process according to Claim 17, characterised in that the undesired deformation is determined from a reference measurement.

19. Process according to Claim 17 ~~or 18~~, characteri~~s~~zed in that the subtraction of the whole-body deformation or undesired deformation from the total deformation in the images or phase images is performed prior to formation of the sum of the differentials between the images or phase images.

20. Apparatus for recording the deformation of objects (1) with a measuring device (2) for recording the sequence of images of the object (1) during the deformation of

said object, and with an evaluation device for forming the differential between two sequential images and for integrating the differential.

21. Apparatus according to Claim 20, characterised in that the measuring device exhibits an interferometry device.

22. Apparatus according to Claim 20, characterised in that the measuring device features a projection device.

23. Apparatus according to ~~one of~~ Claim~~s~~ 20 ~~to 22~~, characteri~~s~~zed by a device for determining phase images from the recorded images.

24. Apparatus according to ~~one of~~ Claim~~s~~ 20 ~~to 23~~, characteri~~s~~zed in that the measuring device encompasses a source for coherent radiation or coherent light or partially coherent radiation or partially coherent light.

25. Apparatus according to ~~one of~~ Claim~~s~~ 20 ~~to 24~~, characteri~~s~~zed by one or several laser diodes.

26. Apparatus according to ~~one of~~ Claim~~s~~ 20 ~~to 25~~, characteri~~s~~zed by a hand-held sensor.

27. Apparatus according to ~~one of~~ Claim~~s~~ 20 ~~to 26~~, characteri~~s~~zed by a device for visuali~~s~~zation of the recorded images or phase images as a film.